GEOLOGY AND PRODUCTION HISTORY OF THE BIG CHIEF URANIUM MINE, NAVAJO COUNTY, ARIZONA

by

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INTRODUCTION

The Big Chief Mine was one of six uranium mines located on the eastern flank of the Oljeto syncline in the Monument Valley area of Navajo County, Arizona, and developed during the 1950's by the Industrial Uranium Company of Salt Lake City, Utah. Of these six mines (Big Chief, Moonlight, Starlight, Starlight East, Sunlight, and Sunlight South), the Big Chief was the shallowest and produced the least uranium (Table 1).

A map of the underground workings (Figure 1) and other data pertaining to the Big Chief Mine were recently located in the files of the U.S. Geological Survey (USGS) at the Denver Federal Center.[1] Warren I. Finch of the USGS permitted me to copy the map for the Arizona Geological Survey. Most of the information in this report is from U.S. Atomic Energy Commission (AEC) documents. John J. Borkert, a former mining engineer with the Industrial Uranium Company of Salt Lake City, Utah, supplied pertinent details about the mine.

LOCATION AND LAND STATUS

The Big Chief Mine was approximately 15 miles north of the junction of U.S. Highways 163 and 160 in Kayenta, Arizona, and 3.4 miles to the west on a graded road (Figure 2). On the Boot Mesa topographic map, the mine site is designated as a Mine Shaft just under the "O" in "RESERVATION" (U.S. Geological Survey, 1988).

The mine was within the Navajo Indian Reservation. Mining permits and leases were issued by the Navajo Tribal Council and approved by the Bureau of Indian Affairs (BIA), U.S. Department of the Interior. Mining permits could be obtained by individual Navajos only. Permit holders could assign the mining rights to another individual or a company; like the permits, these assignments had to be approved by the Tribal Council and the BIA. Leases could be issued directly by the BIA. Permits and leases were awarded for 2-year terms but could be renewed. No more than 960 acres of tribal land could be held by any one company or individual. Both the permittee and the tribe received royalties from ore production. Based on the mine value of the ore, the tribe received between 10% and 20% royalties and the permittee between 2% and 5% royalties.

In addition to mining permits, the tribe issued drilling and exploration permits. These permits were good for 120 days and were not renewable.

GEOLOGIC SETTING

The Big Chief ore deposit was one of several uranium-ore deposits located by "blind" drilling in the El Capitan Flat area of Monument Valley. The Flat is a large, sand-dune-covered area on the eastern side of Oljeto Wash (Figure 2), which roughly follows the axis of the Oljeto syncline. This syncline is between the Organ Rock anticline

to the west and the crest of the Monument Uplift to the east. Underlying the dune sand in the El Capitan Flat area is the Upper Triassic Chinle Formation. Rocks of this formation dip approximately 5° to the west into the syncline (Witkind and Thaden, 1963).

The orebodies at the Big Chief Mine were formed in a channel deposit in the basal portion of the Shinarump Member of the Chinle Formation. The channel, scoured into the underlying Middle Triassic Moenkopi Formation, was filled with medium- to coarse-grained sandstone and conglomerate. Carbonaceous plant materials, including fossil logs, were abundant in the channel sediments. The channel outline as determined by company drilling is shown in Figure 1. The channel is approximately 300 feet wide and has a depth of approximately 50 feet. A smaller distributary channel appears to branch off to the northeast (Figure 1).

Uraninite was the principal uranium mineral. Copper sulfides such as chalcocite, bornite, and chalcopyrite were also present in the ore. Data compiled by Roger C. Malan, of the AEC, for his published report on Monument Valley (Malan, 1968) indicate that the ore shipped from the Big Chief Mine contained an average of 0.96% copper. The Texas-Zinc Minerals Corporation (TZM), which processed the ore at its mill in Mexican Hat, Utah, paid only for copper sulfide in the ore. Studies done by the Industrial Uranium Company indicated that 70% of the copper sulfide was present in chalcocite, 20% in bornite, and only a trace in chalcopyrite. Oxidized copper minerals made up less than 5% of the total copper content of the Big Chief ore. Calcium carbonate in the ore averaged less than 6% $CaCO_3$.

The deposit was unoxidized because of a perched water table in the basal Shinarump conglomerate. Water flowed into the mine workings at approximately 80 gallons per hour.

Geologic studies of the ore-bearing channels in Monument Valley (Young and others, 1964) indicate that the Big Chief deposit is located where a major paleochannel makes a sharp bend from north-south to north-northwest. This channel has been traced by drilling for approximately 6 miles from its outcrop near U.S. Highway 163 until it merges with the Bootjack-Big Four channel at the Sunlight South Mine (Young and others, 1964). South of the Big Chief Mine, the channel contains the Firelight No. 6, Alma-Seegan, Black Rock, and Sally deposits (Scarborough, 1981).

PRODUCTION HISTORY

During 1955, numerous Navajos acquired permits to hold land for mining on the sand-covered flats along El Capitan Wash, on the eastern flank of the Oljeto syncline. They applied for these permits in anticipation of exploration drilling that was to be done by companies looking for uranium deposits farther west, near the axis of the syncline. By early 1956, more than 25 square miles on the eastern flank of the Oljeto syncline had been acquired by mining permits. A portion of the area is shown in Figure 3.

On November 16, 1955, Walter Chief of Kayenta, Arizona, was granted Navajo Tribal Mining Permit (MP) No. 375[2]. This permit consisted of 217.2 acres and included the Big Chief Nos. 3 and 4 claims (Figure 3). On November 23, 1956, the Industrial Uranium Company was issued a drilling permit covering 549.6 acres, which included all of Walter Chief's 217.2 acres and portions of adjacent permits held by Vern Salt and

Roy Grey (Figure 3). By this time, Industrial Uranium had already found the Moonlight, Starlight, and Sunlight deposits and had begun to mine the Moonlight via a decline (Table 1).

Industrial Uranium drilled a total of approximately 20,000 feet and located orebodies on the Big Chief Nos. 3 and 4 claims (Figure 1). The orebodies were at an average depth of 150 feet and ranged between 2.3 and 24 feet in thickness, with an average thickness of 7.9 feet. They reportedly contained 38,000 tons of ore, which averaged 0.22% U_3O_8.

Having been successful in locating ore, Industrial Uranium obtained the assignment of the mining rights to MP-375 on April 3, 1957, from Walter and Bertha Chief. This assignment was approved by the Tribal Council on September 4, 1957, and the BIA on November 4, 1957. After obtaining control of the mining permit, Industrial Uranium continued exploration and development drilling and in December 1958 began to sink a 470-foot-long, 19° decline into the westernmost orebody.

On March 18, 1958, while the orebodies were still being drilled, Industrial Uranium and the Chiefs applied to the BIA to convert the mine permit into a lease. Lease No. 14-20-603-5057 was approved by the BIA on March 26, 1959. This was about the same time that the initial shipment of ore was made to the TZM mill at Mexican Hat, only 30 miles away. As mentioned above, the mill recovered copper as well as uranium from the ores it processed.

When the Big Chief Mine was examined by AEC geologists and engineers in August 1959, it was employing 13 men in two shifts. A modified room-and-pillar method of mining was being used with on-level ore haulage. Underground longhole drilling continued to locate ore ahead of the working faces.

During 1959, 6,993.15 tons of ore averaging 0.24% U_3O_8 (Table 2) were shipped to the mill at Mexican Hat. The map (Figure 1) shows the extent of the mine workings in January 1960 after approximately 8,000 tons of ore had been mined.

Mining continued throughout 1960 at the rate of approximately 1,500 tons per month, with an average grade of 0.24% U_3O_8. Mining continued at a decreased rate during 1961. During that year only 7,223.48 tons of ore were mined, with an average grade of 0.20% U_3O_8 (Table 1). By year's end all of the economic ore had been mined out, and the mine was closed in December.

During the 33 months that the Big Chief Mine was active, it produced a total of 32,833.75 tons averaging 0.23% U_3O_8 (Table 2) and 0.96% Cu. All of the ore was processed at the TZM mill at Mexican Hat. The uranium concentrate from the ore was sold to the AEC, and the copper concentrates were sold to a smelter in Arizona.

ACKNOWLEDGMENTS

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[1]This information is part of the collection of geological data that was moved to the Denver Federal Center by the Department of Energy (DOE). In 1983 the uranium resource and liaison programs of the DOE were transferred from Grand Junction, Colorado, to Washington, D.C. During the next few years, all of the geologic data and publications that the AEC, Energy Research and Development Administration, and DOE had collected and produced from 1947 to 1983 were relocated to the USGS in Denver.

[2]Legal Description of Navajo Tribal Mining Permit No. 375: "Commencing at the No. 2 corner of Big Chief No. 2 claim, which bears N55°37'W., 14,104 feet from U.S. Indian Service Mineral Monument No. 4; running thence along the northwest boundary of the Lake Bed Claim, N27°32'E, 596.6 feet, to corner No. 1; thence N14°34'W, 1,944 feet, more or less, to corner No. 2 on the southeast line of the Big Four No. 4 claim; thence N38°08'E, 2,359.8 feet to corner No. 3, being the No. 2 corner of the Big Four No. 2 claim; thence N55°50'E, 2,771 feet along the south line of the Blood, Tears, and Sweat claims to corner No. 4; thence South 2,740 feet to corner No. 5; thence S55°50'W, 3,607 feet, more or less, to corner No. 1, containing 217.2 acres, more or less."

--From the files of the Navajo Tribal Mining Department, Window Rock, Arizona.

Table 1. Ore production by Industrial Uranium Company, Navajo County, Arizona.

MINE	YEARS SHIPPING ORE	TONS OF ORE	POUNDS U_3O_8	% U_3O_8
Big Chief	1959-1961	32,833.75	151,221.03	0.23
Moonlight	1956-1966	223,236.77	1,177,501.29	0.26
Starlight	1958-1961	40,378.25	231,730.52	0.29
Starlight East	1961-1964	45,990.38	289,377.67	0.31
Sunlight	1958-1964	55,023.51	291,461.88	0.26
Sunlight South	1962-1965	28,644.74	171,459.83	0.30

Source: Unpublished ore-production records, U.S. Atomic Energy Commission, Grand Junction, Colorado.

Table 2. Ore production, Big Chief Mine, Navajo County, Arizona.

YEAR	SHIPPER	TONS OF ORE	POUNDS U_3O_8	% U_3O_8
1959	Industrial Uranium	6,993.15	33,309.59	0.24
1960	Industrial Uranium	18,617.12	88,459.08	0.24
1961	Industrial Uranium	7,223.48	29,452.36	0.20
Total		32,833.75	151,221.03	0.23

Source: Unpublished ore-production records, U.S. Atomic Energy Commission, Grand Junction, Colorado.

Figure 1. Plan map of the Big Chief uranium mine, Navajo County,

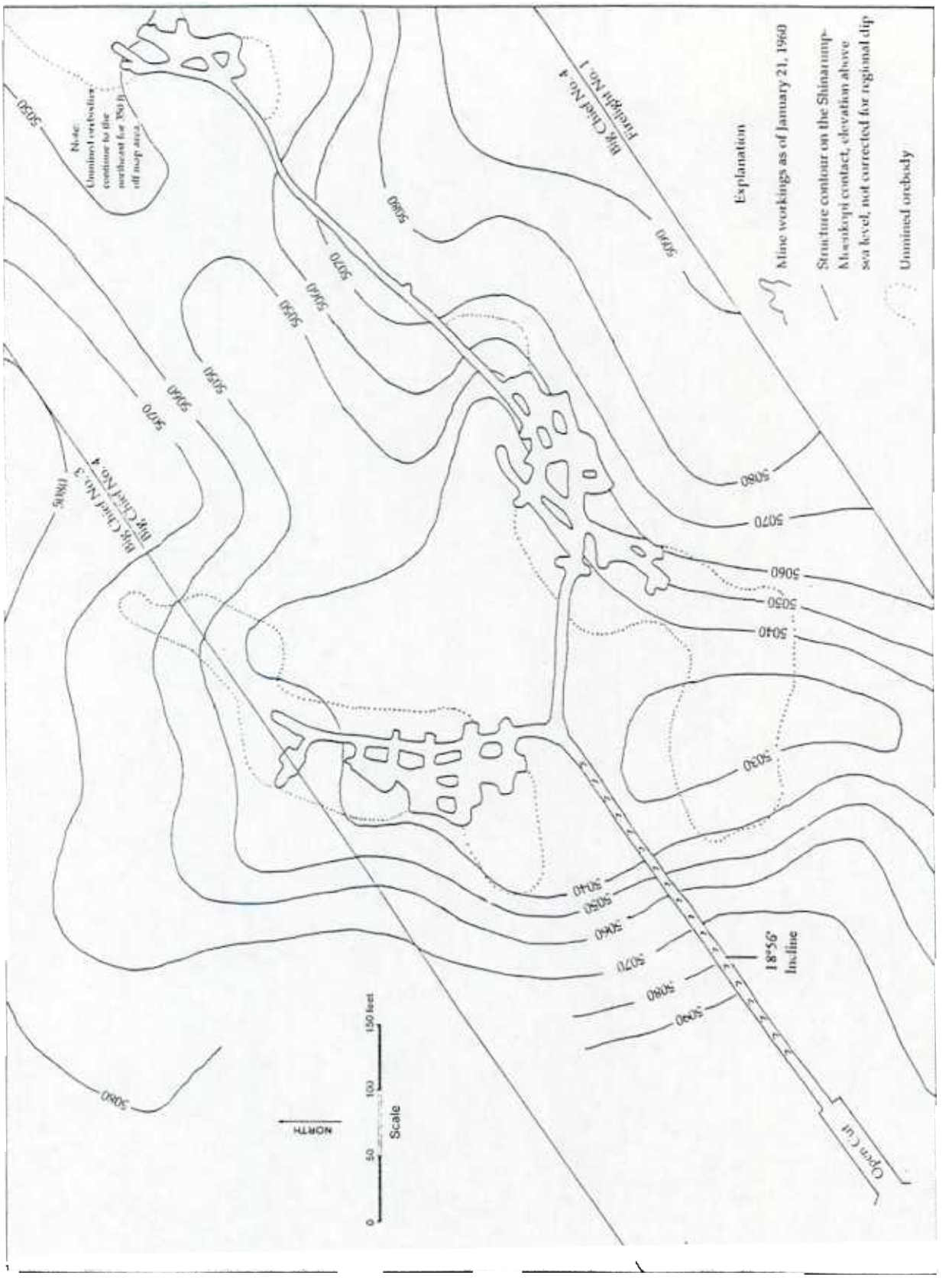

Figure 2. Index map of Monument Valley, Arizona-Utah, showing the location of the Big Chief uranium mine.

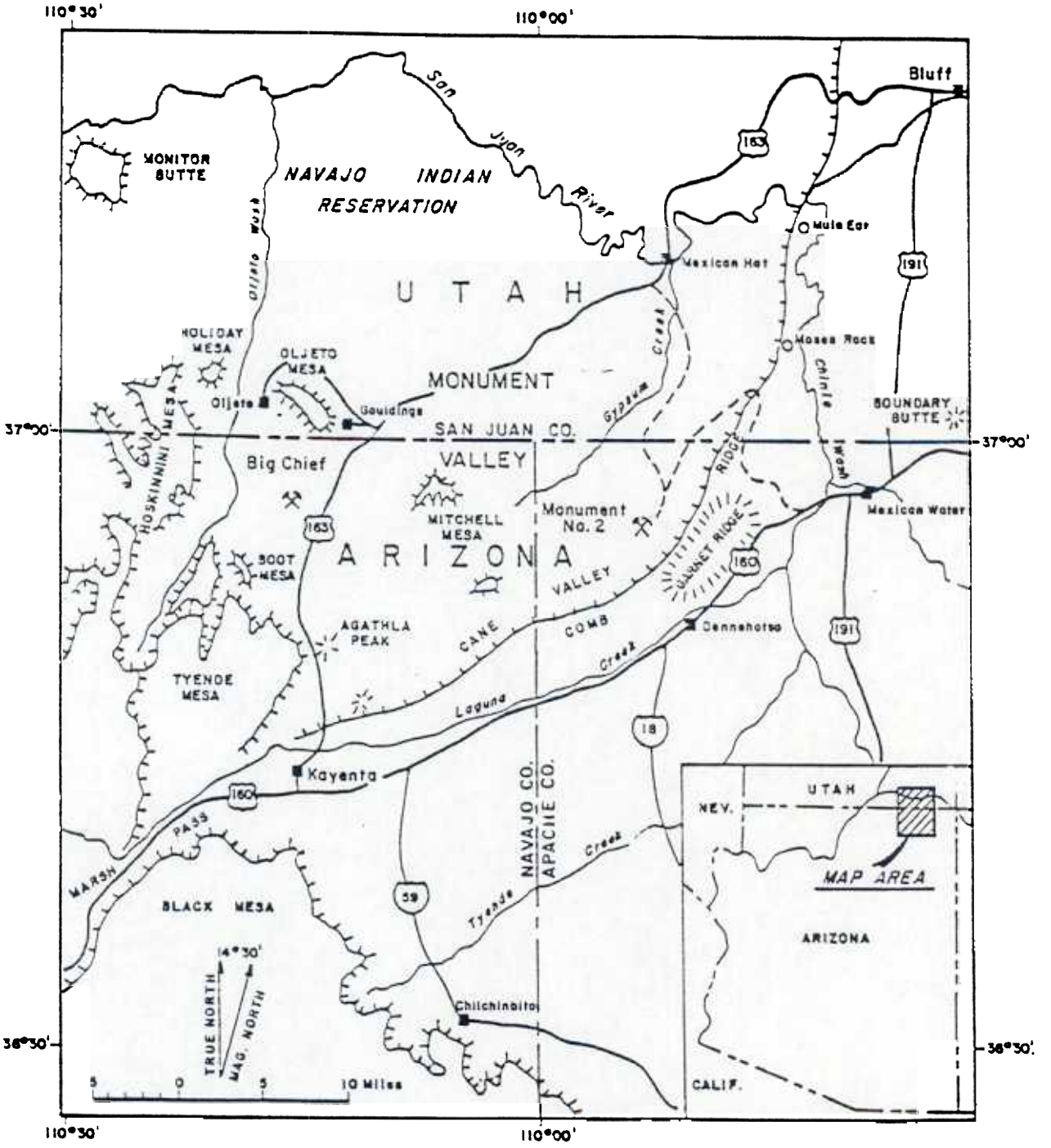

Figure 3. Map showing mining permits and leases adjacent to the Big Chief uranium mine.